

Preliminary screening of dry- and wet-recovered starchy fractions from *Persea americana* and *Mangifera indica* seeds for bioplastic formulation

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Supplementary Material S1

S1. Scope and analytical unit

The source files contain 12 observations from a 2×2 factorial arrangement with three separately weighed process runs per treatment. They do not contain identifiers for independent biological lots. The analytical unit is therefore a process replicate within the sampled material, and inference is limited to these runs.

The initial mass column is the as-weighed seed material assigned to a run. Recovered fraction yield uses that wet-basis/as-is denominator without initial-moisture correction. The recovered-mass field is reproduced exactly as stored, although its decimal precision exceeds the reporting resolution of the initial mass. Statistical analyses use the recorded percentage response.

Table S1. Raw data by process replicate

Code	Rep.	Seed	Method	Initial mass (g)	Recovered mass field (g)	Yield (%)	Moisture (%)	Ash (%)
S1M1	1	Mango	Dry	748.23	145.904850	19.50	6.12	2.50
S1M1	2	Mango	Dry	731.64	142.742964	19.51	6.85	2.56
S1M1	3	Mango	Dry	755.82	147.536064	19.52	7.68	2.62
S1M2	1	Mango	Wet	751.09	210.154982	27.98	11.34	2.54
S1M2	2	Mango	Wet	744.52	208.391148	27.99	12.08	2.58
S1M2	3	Mango	Wet	758.71	212.438800	28.00	12.79	2.60
S2M1	1	Avocado	Dry	742.17	137.301450	18.50	6.43	2.90
S2M1	2	Avocado	Dry	759.36	140.557536	18.51	7.10	2.95
S2M1	3	Avocado	Dry	736.48	136.396096	18.52	7.92	3.00
S2M2	1	Avocado	Wet	730.85	87.555830	11.98	20.36	3.20
S2M2	2	Avocado	Wet	746.33	89.484967	11.99	21.14	3.25
S2M2	3	Avocado	Wet	753.27	90.392400	12.00	21.88	3.30

Note. Mango and avocado denote *Mangifera indica* L. and *Persea americana* Mill., respectively. Yield is recovered fraction yield, not verified starch purity.

Table S2. Formula definitions and calculation basis

Item	Expression and implementation
Recovered fraction yield	$Y_{RF}(\%) = (m_{RF,dry} / m_{initial,as-is}) \times 100$. Same as-weighed seed denominator for wet and dry routes; no moisture correction.
Moisture	$H(\%) = [(m_{initial} - m_{dry}) / m_{initial}] \times 100$.
Ash	$C_{ash}(\%) = (m_{ash} / m_{dry}) \times 100$.
Cell mean	$\bar{y}_g = \sum y_{ig} / n_g$, where $n_g = 3$ process replicates.
Sample standard deviation	$s_g = \sqrt{[\sum (y_{ig} - \bar{y}_g)^2 / (n_g - 1)]}$.
Factorial residual	$e_{ijk} = y_{ijk} - \bar{y}_{ijk}$; fitted values are the four treatment-cell means.
Brown-Forsythe test	$z_{ij} = y_{ij} - \text{median}_j $, followed by one-way ANOVA on z_{ij} .
Exact permutation test	All 369,600 allocations of 12 observations into four labelled groups of three were evaluated. Exact $p = \text{count}(F_{perm} \geq F_{obs}) / 369,600$.



S2. Descriptive statistics

Table S3. Treatment-level descriptive results

Response	Treatment	n	Mean	SD	CV (%)	95% CI lower	95% CI upper
Yield	Mango dry	3	19.5100	0.0100	0.0513	19.4852	19.5348
Yield	Mango wet	3	27.9900	0.0100	0.0357	27.9652	28.0148
Yield	Avocado dry	3	18.5100	0.0100	0.0540	18.4852	18.5348
Yield	Avocado wet	3	11.9900	0.0100	0.0834	11.9652	12.0148
Moisture	Mango dry	3	6.8833	0.7805	11.3395	4.9444	8.8223
Moisture	Mango wet	3	12.0700	0.7251	6.0071	10.2689	13.8711
Moisture	Avocado dry	3	7.1500	0.7463	10.4372	5.2962	9.0038
Moisture	Avocado wet	3	21.1267	0.7601	3.5978	19.2385	23.0148
Ash	Mango dry	3	2.5600	0.0600	2.3438	2.4110	2.7090
Ash	Mango wet	3	2.5733	0.0306	1.1872	2.4974	2.6492
Ash	Avocado dry	3	2.9500	0.0500	1.6949	2.8258	3.0742
Ash	Avocado wet	3	3.2500	0.0500	1.5385	3.1258	3.3742

S3. Factorial ANOVA and model fit

Table S4. Two-factor ANOVA with interaction

Response	Source	df	SS	MS	F	p
Yield	Seed	1	216.750000	216.750000	2167500.00	<0.001
Yield	Method	1	2.881200	2.881200	28812.00	<0.001
Yield	Seed x method	1	168.750000	168.750000	1687500.00	<0.001
Yield	Error	8	0.000800	0.000100		
Moisture	Seed	1	65.193408	65.193408	114.90	<0.001
Moisture	Method	1	275.425008	275.425008	485.42	<0.001
Moisture	Seed x method	1	57.948075	57.948075	102.13	<0.001
Moisture	Error	8	4.539133	0.567392		
Ash	Seed	1	0.853333	0.853333	358.04	<0.001
Ash	Method	1	0.073633	0.073633	30.90	<0.001
Ash	Seed x method	1	0.061633	0.061633	25.86	<0.001
Ash	Error	8	0.019067	0.002383		

Note. Seed and method are fixed factors. Error df = 8 for each response.

Table S5. Model fit

Response	S	R ² (%)	Adjusted R ² (%)	Predicted R ² (%)	Model F	Model p
Yield	0.010000	99.999794	99.999717	99.999537	1294604.00	<0.001
Moisture	0.753254	98.873959	98.451694	97.466408	234.15	<0.001
Ash	0.048819	98.107840	97.398280	95.742640	138.27	<0.001

S4. Assumption checks and sensitivity analysis

Table S6. Residual normality and variance homogeneity

Response	Shapiro W	Shapiro p	Normality decision	Brown-Forsythe F	Brown-Forsythe p	Variance decision
Yield	0.8108	0.012459	Departure detected	0.0000	1.000000	Homogeneity supported
Moisture	0.8374	0.025728	Departure detected	0.0038	0.999651	Homogeneity supported
Ash	0.9215	0.298583	No detected departure	0.2585	0.853331	Homogeneity supported

Note. At $\alpha = 0.05$, yield and moisture residuals depart from normality. The balanced design and variance results do not remove the small-n limitation, so exact permutation tests were added.

Table S7. Exact omnibus treatment-label permutation tests

Response	Observed F	Extreme allocations	Total allocations	Exact p
Yield	1294604.00	24	369600	0.00006494
Moisture	234.15	168	369600	0.00045455
Ash	138.27	216	369600	0.00058442

S5. Residual and influence table

Table S8. Observed values, fitted values and residual diagnostics

Response	Treatment	Rep.	Observed	Fitted	Residual	Std. residual	Cook's D
Yield	Mango dry	1	19.5000	19.5100	-0.010000	-1.2247	0.18750
Yield	Mango dry	2	19.5100	19.5100	0.000000	0.0000	0.00000
Yield	Mango dry	3	19.5200	19.5100	0.010000	1.2247	0.18750
Yield	Mango wet	1	27.9800	27.9900	-0.010000	-1.2247	0.18750
Yield	Mango wet	2	27.9900	27.9900	0.000000	0.0000	0.00000
Yield	Mango wet	3	28.0000	27.9900	0.010000	1.2247	0.18750
Yield	Avocado dry	1	18.5000	18.5100	-0.010000	-1.2247	0.18750
Yield	Avocado dry	2	18.5100	18.5100	0.000000	0.0000	0.00000
Yield	Avocado dry	3	18.5200	18.5100	0.010000	1.2247	0.18750
Yield	Avocado wet	1	11.9800	11.9900	-0.010000	-1.2247	0.18750
Yield	Avocado wet	2	11.9900	11.9900	0.000000	0.0000	0.00000
Yield	Avocado wet	3	12.0000	11.9900	0.010000	1.2247	0.18750
Moisture	Mango dry	1	6.1200	6.8833	-0.763333	-1.2411	0.19255
Moisture	Mango dry	2	6.8500	6.8833	-0.033333	-0.0542	0.00037
Moisture	Mango dry	3	7.6800	6.8833	0.796667	1.2953	0.20974
Moisture	Mango wet	1	11.3400	12.0700	-0.730000	-1.1869	0.17610
Moisture	Mango wet	2	12.0800	12.0700	0.010000	0.0163	0.00003
Moisture	Mango wet	3	12.7900	12.0700	0.720000	1.1707	0.17131
Moisture	Avocado dry	1	6.4300	7.1500	-0.720000	-1.1707	0.17131
Moisture	Avocado dry	2	7.1000	7.1500	-0.050000	-0.0813	0.00083
Moisture	Avocado dry	3	7.9200	7.1500	0.770000	1.2520	0.19593
Moisture	Avocado wet	1	20.3600	21.1267	-0.766667	-1.2466	0.19424
Moisture	Avocado wet	2	21.1400	21.1267	0.013333	0.0217	0.00006
Moisture	Avocado wet	3	21.8800	21.1267	0.753333	1.2249	0.18754



Ash	Mango dry	1	2.5000	2.5600	-0.060000	-1.5052	0.28322
Ash	Mango dry	2	2.5600	2.5600	0.000000	0.0000	0.00000
Ash	Mango dry	3	2.6200	2.5600	0.060000	1.5052	0.28322
Ash	Mango wet	1	2.5400	2.5733	-0.033333	-0.8362	0.08741
Ash	Mango wet	2	2.5800	2.5733	0.006667	0.1672	0.00350
Ash	Mango wet	3	2.6000	2.5733	0.026667	0.6690	0.05594
Ash	Avocado dry	1	2.9000	2.9500	-0.050000	-1.2544	0.19668
Ash	Avocado dry	2	2.9500	2.9500	0.000000	0.0000	0.00000
Ash	Avocado dry	3	3.0000	2.9500	0.050000	1.2544	0.19668
Ash	Avocado wet	1	3.2000	3.2500	-0.050000	-1.2544	0.19668
Ash	Avocado wet	2	3.2500	3.2500	0.000000	0.0000	0.00000
Ash	Avocado wet	3	3.3000	3.2500	0.050000	1.2544	0.19668

Note. Leverage is 1/3 for every observation in this balanced cell-means model. No Cook's distance exceeded 1.0.

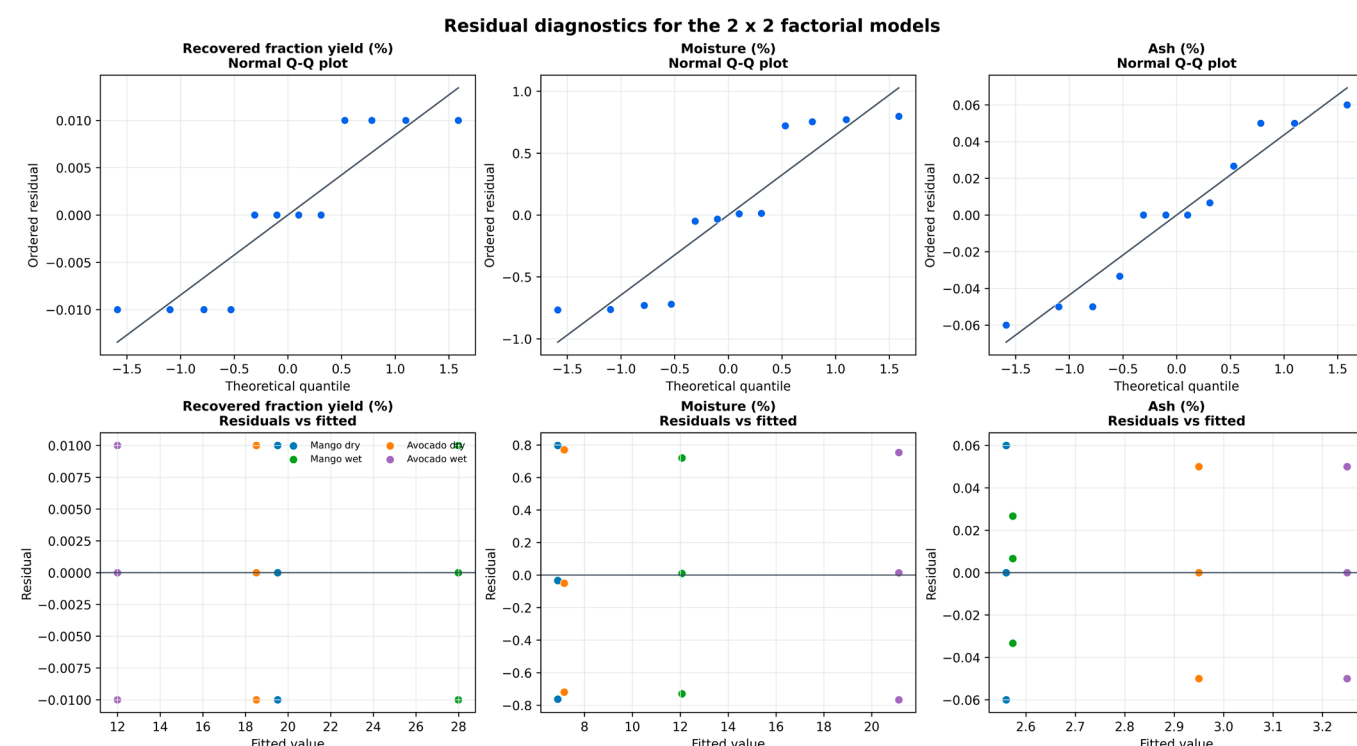


Figure S1. Residual diagnostic plots

Figure S1. Normal Q-Q plots and residual-versus-fitted plots for recovered fraction yield, moisture and ash. The repeated three-level pattern in yield and the near-symmetric three-level pattern in moisture explain the Shapiro-Wilk departures. Residual spread remains similar across treatment cells.

S6. Interpretation and limits

The extremely large yield F statistics are arithmetically explained by the treatment contrasts relative to $MSE = 0.0001$. The four yield cells each have $SD = 0.01$ percentage points. Reporting R^2 to six decimals prevents a rounded value of 100.00% from being mistaken for an error-free model.

The exact permutation tests support overall separation among the four treatment combinations, including when normality is not assumed. They do not convert process replicates into biological replicates. The findings cannot be generalised across cultivars, harvest periods or supplier lots without independent biological replication.

The source files do not contain the intermediate gravimetric readings required to reconstruct moisture and ash from crucible-level masses. They contain the final percentage responses reproduced in Table S1. No replacement or estimated raw measurements were introduced.